***NATIONAL WEATHER SERVICE EASTERN REGION SUPPLEMENT 02-2004***
***APPLICABLE TO NWSI 10-1601***
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***Operations and Services***
***Public Weather Services, NDS 10-5***
***WFO Non-precipitation Weather Products Specification, NWSPD 10-515***
***Performance, NWSPD 10-16 Verification Procedures, NWSI 10-1601***

# *HIGH WIND WARNING VERIFICATION IN EASTERN REGION*

**NOTICE:** These publications are available at: http://www.nws.noaa.gov/directives/.

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**Type of Issuance:** Routine

***SUMMARY OF REVISIONS:*** This supplement supersedes NDS Supplement 02-2004 dated January 15, 2004 and updates sections 4.8 (Lead Time), 4.10 (Expansion/Extension Rules) and 4.11 (Combined Events). Appendix B contains new examples demonstrating lead time computation with the new extension rule, and how to handle combined events.

< Signed > November 17, 2005

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Director, NWS Eastern Region

# High Wind Warning Verification

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**1.** **Purpose.** The purpose of High Wind Warning verification is to accurately assess NWS wind warning performance and identify areas for service improvement.

**2.** **Background.** Verification of high wind warnings can be done many ways. This supplement provides standardized guidelines so annual verification statistics can be compared.

**3.** **Responsibility.** All Eastern Region (ER) Weather Forecast Offices (WFOs) are responsible for following these verification guidelines. ER Headquarters is responsible for compiling and posting summaries of seasonal statistics for WFO viewing.

## 4. Guidelines.

4.1 Verification Area. Verification for high wind warnings is based on individual public zones. Thus, a high wind warning (NPW) product covering three zones counts as three separate warnings.

4.2 High Wind Warning Verification. NWSI 10-515 discusses the multi-tiered concept for non-precipitation (NPW) watches, warnings and advisories. However, the only NPW product ER offices are required to manually verify is the high wind warning.

4.3 Issuance Trigger. High wind watches/warnings are triggered when sustained wind of 40 MPH or greater for an hour or more, or a peak gust $\geq$ 58 MPH for any duration, is forecast or occurring. For watch issuance, a 50% or greater chance of reaching either threshold must exist; for warning issuance, 80% or greater.

Watches and warnings may, on occasion, be triggered when significant public impact is expected, even though quantitative thresholds are not likely to be met. For watch issuance, a 50% or greater chance of significant public impact must exist; for warning issuance, 80% or greater.

4.4 Event Definition. A high wind event has occurred whenever sustained winds of 40 MPH or more, or a peak gust of 58 MPH or more, has been reported from reliable observing equipment. Public impact such as power outages or damage to trees, roofs, windows or cars can also be used to indicate that a high wind event has occurred.

4.5 Warned Event (Hit). An event has been warned for when it occurs in a warned zone during the valid period of the warning.

4.6 Warning without an event (False Alarm). A warning without an event occurs when an event fails to materialize within the warned zone during the valid period of the warning.

4.7 Missed Events. Missed events occur when:

a. wind speeds observed in a zone meet or exceed the warning threshold when no warning was in effect, or

b. significant public impact occurs in a zone that would justify a warning when none was in effect,

c. warnings are downgraded to advisories, then warning criteria are subsequently met or exceeded during the storm, or

d. weather events continue beyond the end time of a warning, resulting in warning criteria being met once again (see Attachment B for an example).

4.8 Lead Time. Compute a lead time for each zone that experiences an event. Subtract the time of warning issuance (WMO header line time stamp) from the time when the event first met warning criteria in the zone, or significant public impacts began. Set negative values to zero. If a zone experiences an event outside of the Valid Time Event Code (VTEC) window, assign that event a lead time of zero. Compute average lead time from all the lead times listed in the event database, including zeros.

4.9 Percent of Events with Zero Lead Time. Compute the percent of events with zero lead time by dividing the number of events with no lead time by the total number of events. Events with zero lead time include all missed events, plus warned events with no lead time.

4.10 Expansion/Extension Rules. Expansion of warnings into new areas (zones) count as new warnings, with lead times computed from the new issuance time in accordance with section 4.8. Extensions in time for zones already warned but not yet meeting warning criteria are counted as new warnings as well. If the initial warning and extension warning time windows overlap, and an event occurs within this overlap, lead time is computed from the initial warning issuance time. If the event happens outside the initial warning's time window, but falls within the extension's VTEC time window, lead times are computed from the extension's issuance time, with the initial warning tallied as a false alarm.

4.11 Combined Events. When winter storm and high wind events occur simultaneously, a WSW should be used to cover both phenomena (typically blizzard conditions or considerable blowing and drifting snow will also be present). The WSW may be verified based on the amount of precipitation that accumulates, blizzard conditions or public impact.

NPWs should be used for stand-alone wind events - situations where snow is not falling or blowing around. The NPW is verified based on reported wind speeds or public impact.

In cases where less than six hours of overlap is expected between WSW and NPW events (e.g. precipitation is winding down while winds are increasing or visa versa), separate WSW and NPW products should be issued, and verified as discrete events.

4.12 Inland Tropical Storm/Inland Hurricane Wind Warnings. Inland Tropical Storm Wind Warnings are issued for and verified by sustained winds of 39 - 73 MPH, or significant public impact. Inland Hurricane Wind Warnings are issued for and verified by sustained winds of 74 MPH or more, or significant public impact. Wind Warning statistics generated from these tropical systems will be composited with those of extra-tropical systems and reported with attachment A.

4.13 Storm Episode. A storm episode is defined as any storm system that produces phenomena reaching or exceeding warning criteria in one or more zones. Individual storm episodes may be generated by a single synoptic scale system, an individual tropical cyclone, or a mesoscale event such as local terrain channeling.

4.14 Verification Equations. Equations for computing Probability of Detection (POD), False Alarm Ratio (FAR), Critical Success Index (CSI), Lead Time (LT) and Percent of Events with Zero LT (% 0 LT) are listed below:

$$\text{POD} = \frac{\text{\# of warned events}}{\text{total \# of events}}$$

$$\text{FAR} = \frac{\text{\# of warnings without an event}}{\text{total \# of warnings}}$$

$$\text{CSI} = \frac{\text{\# of warned events}}{(\text{\# of warnings without an event}) + (\text{total \# of events})}$$

LT = (initial time criteria is reached) - (issuance time of warning)

$$\%\ 0\ \text{LT} = \frac{(\text{\# of missed events}) + (\text{\# warned events with no lead time})}{\text{total \# of events}} \times 100$$

4.15 Reporting Procedures. Events occurring from October 1 through December 31 of any calendar year will be tallied for the entire CWA and reported to ERH MSD no later than the following January 31. A cumulative tally encompassing the period from October 1 to March 31 will be reported no later than April 30. Isolated late season storms between March 31 and May 31 must be reported no later than June 30. Any storms occurring the remainder of the fiscal year (e.g. tropical storm high wind warnings) through September 30 must be reported no later than October 15.

Use Attachment A to summarize and report verification numbers to ERH.

4.16 Verification Records. Annual verification statistics should be kept on a zone by zone basis at each WFO to document and improve services on spatial scales smaller than the entire CWA. ERH will keep summaries of high wind verification statistics for the entire region and make this information freely available for all Weather Forecast Offices to review.

## Attachment A - High Wind Warning Verification Summary Sheet

WFO _____ Fiscal Year _____

| High Wind Warnings | OCT-DEC | OCT-MAR | OCT-SEP |
|---|---|---|---|
| Number of Warnings Issued | _____ | _____ | _____ |
| Warnings with an event | _____ | _____ | _____ |
| Warnings without an event | _____ | _____ | _____ |
| Probability of Detection | _____ | _____ | _____ |
| False Alarm Ratio | _____ | _____ | _____ |
| Critical Success Index | _____ | _____ | _____ |
| Average (Event-based) Lead Time | _____ | _____ | _____ |
| % 0 LT | _____ | _____ | _____ |

High Wind Event Summary

| | | | |
|---|---|---|---|
| Number of Events | _____ | _____ | _____ |
| Number of Storm Episodes | _____ | _____ | _____ |

$$POD = \frac{\text{\# of warned events}}{\text{total \# of events}} \qquad FAR = \frac{\text{\# of warnings without an event}}{\text{total \# of warnings}}$$

$$CSI = \frac{\text{\# of warned event}}{(\text{\# of warnings without an event}) + (\text{total \# of events})}$$

LT = (initial time criteria is reached) - (issuance time of warning)

$$\%\ 0\ LT = \frac{(\text{\# of missed events}) + (\text{\# of warned events with no lead time})}{\text{total \# of events}} \times 100$$

## Attachment B - Verification Examples

**Example 1 - reference section 4.7.c - Missed Events.**

A high wind warning in effect for Franklin County is downgraded to an advisory at 11 AM, as sustained winds are only 35 MPH with occasional gusts to 50 MPH. At 2 PM, a wind gust of 60 MPH is reported. This is counted as both a false alarm and a missed event, because the warning threshold was not met within the valid time window, but was met outside the window. The same result would occur if the warning had been canceled or expired at 11 AM, rather than downgraded.

**Example 2 - reference section 4.8 - Seasonal Lead Time computation.**

Seasonal lead time computations must use a weighted average of each storm episode's lead time rather than a simple average. Thus, an office with two storms will have:

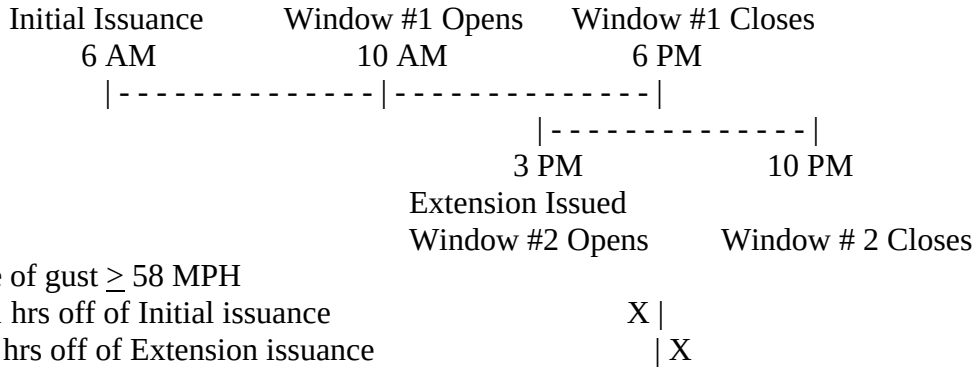
((20 zones x 12 hr) + (36 zones x 16 hr)) / 56 zones, yielding the correct LT of 14.57 hours, rather than a simple average of (12 hr + 16 hr) / 2, which gives an incorrect LT of 14 hours.

Alternatively, each individual event lead time through the whole season can be used to compute the average lead time.

**Example 3 – reference section 4.10 – Extension Rules.**

At 6 AM the mid-shift issues a high wind warning for Franklin County with a VTEC event time window from 10 AM until 6 PM. At 3 PM, the strong winds still haven't hit, but are expected to begin soon and continue through 10 PM. An extension is issued at 3 PM to extend the warning until 10 PM. At 7 PM the first wind gust $\geq$ 58 MPH is reported in Franklin County. The initial warning is tallied as a false alarm. The extension is counted as a hit, with a lead time of 4 hours.

Had the first wind gust $\geq$ 58 MPH occurred during the warning overlap time (say 5 PM), a lead time of 11 hours would be computed off of the initial warning (5 PM minus 6 AM = 11 hours). Graphically, the cases look like this:



**Example 4 – reference section 4.11 – Combined Events.**

A winter storm with significant snow accumulation is winding down, but winds behind the storm system are increasing and expected to reach wind warning criteria a few hours before the snow ends, then continue another 12 hours after that. An NPW should be issued before the WSW expires to address the wind situation. The WSW is verified based on snow accumulation; the NPW is verified separately based on high wind or wind damage reports.